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APRIL 12, 2003

NEBRASKA HEALTH AND HUMAN SERVICES
REGULATION AND LICENSURE

180 NAC 13

TITLE 180. CONTROL OF RADIATION

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Attachment 13.1 39 CFR Part 111, § 111.1

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A copy of the Code of Federal Regulations (CFR) cited in this Chapter are available for review at the Department of Health and Human Services Regulation and Licensure, 301 Centennial Mall South, Lincoln, NE 68509

10 CFR 1 through 199 (January 1, 2002)
49 CFR 100 through 399 (October 1, 2001)

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TITLE 180 CONTROL OF RADIATION

CHAPTER 13 TRANSPORTATION OF RADIOACTIVE MATERIAL

13-001 SCOPE AND AUTHORITY:

13-001.01 The regulations in this section establish requirements for packaging, preparation for shipment, and transportation of radioactive material and apply to any person who transports radioactive material or delivers radioactive material to a carrier for transport. The regulations are authorized by and implement the Nebraska Radiation Control Act, Neb. Stat. Rev. §§ 71-3501 to 3519.

13-001.02 10 CFR as published on January 1, 2002 and 49 CFR as published October 1, 2001 and referred throughout this Chapter are herein incorporated by reference and available for viewing at the Nebraska Department of Health and Human Services Regulation and Licensure, Public Health Assurance Division, 301 Centennial Mall South, 3rd Floor, Lincoln, Nebraska 68509.

13-002 DEFINITIONS: _ As used in 180 NAC 13, the following definitions apply:

Carrier means a person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

Certificate holder means a person who has been issued a certificate of compliance or other package approval by the Agency.

Close reflection by water means immediate contact by water of sufficient thickness for maximum reflection of neutrons.

Containment system means the assembly of components of packaging intended to retain the radioactive material during transport.

Conveyance means:

For transport by public highway or rail any transport vehicle or large freight container;

For transport by water any vessel, or any hold compartment, or defined deck area of a vessel including any transport vehicle on board the vessel; and

For transport by aircraft any aircraft.

Exclusive use means the sole use of a conveyance by a single consignor for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must issue specific instructions, in writing, for maintenance of exclusive use shipment controls and include them with the shipping paper information provided to the carrier by the consignor.

Fissile material means plutonium-238, plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. Unirradiated natural uranium and depleted uranium, and natural uranium or depleted uranium that has been irradiated in thermal reactors only are not included in this definition.¹

Low specific activity (LSA) Material means radioactive material with limited specific activity that satisfies the descriptions and limits set forth below. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in one of three groups:

LSA-I: Ores containing only naturally occurring radionuclides (e.g., uranium, thorium) and uranium or thorium concentrates of such ores; or

Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures; or

Radioactive material other than fissile material, for which the A_2 value is unlimited; or

Mill tailings, contaminated earth, concrete, rubble, other bulk debris and activated material in which the radioactive material is essentially uniformly distributed, and the average specific activity does not exceed $10^{-6} A_2/g$.

LSA-II: Water with tritium concentration up to 0.8 TBq/liter (20.0 Ci/liter); or

Material in which the active material is distributed throughout, and the average specific activity does not exceed $10^{-4} A_2/g$ for solids and gases, and $10^{-5} A_2/g$ for liquids.

LSA-III solids (e.g., consolidated wastes, activated materials) in which:

The radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.); and

The radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that, even under loss of packaging, the loss of radioactive material per package leaching, when placed in water for 7 days, would not exceed $0.1 A_2$; and

The average specific activity of the solid does not exceed $2 E-3 A_2/g$.

¹Agency jurisdiction extends only to "special nuclear material in quantities not sufficient to form a critical mass" as defined in 180 NAC 1-002.

Low toxicity alpha emitters means natural uranium, depleted uranium, natural thorium; uranium-235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or chemical concentrates; or alpha emitters with a half-life of less than 10 days.

Natural thorium means thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

Normal form radioactive material radioactive material which has not been demonstrated to qualify as "special form radioactive material." "Special form radioactive material" is defined 180 NAC 1-002.

Optimum interspersed hydrogenous moderation means the presence of hydrogenous material between packages to such an extent that the maximum nuclear reactivity results.

Fissile material package means a fissile material packaging together with its fissile material contents.

Type B package means a Type B packaging together with its radioactive contents. On approval, a Type B package design is designated by U. S. Nuclear Regulatory Commission (NRC) as B(U) unless that package has a maximum normal operating pressure or more than 700 kPa (100 lb/in²) gauge or pressure relief device that would allow the release of radioactive material to the environment under the tests specified in 10 CFR Part 71.73 (hypothetical accident conditions), in which it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments; B(M) refers to the need for multilateral approval of international shipments. There is not distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see U. S. Department of Transportation (DOT) regulations, 49 CFR Part 173. A Type B package approved before September 6, 1983, was designated only as Type B. Limitations on its use are specified 180 NAC 13-008.

Packaging means the assembly of components necessary to ensure compliance with the packaging requirements of this section. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie down system, and auxiliary equipment may be designated as part of the packaging.

Specific activity of a radionuclide means the radioactivity of a radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

Surface contaminated object (SCO) means a solid object that is not itself classed as radioactive material but which has radioactive material distributed on any of its surfaces. SCO must be in one of two groups with surface activity not exceeding the following limits:

SCO-1: A solid object on which:

The non-fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4 Bq/cm² (10⁻⁴ μCi/cm²) for beta and gamma and low toxicity alpha emitters, or 0.4 Bq/cm² (10⁻⁵ μCi/cm²) for all other alpha emitters.

The fixed contamination on the accessible surface averaged over 300 cm² (or the area of the surface if less than 300 cm²) does not exceed 4 E4 Bq/cm² (1.0 μCi/cm²) for beta and

gamma and low toxicity alpha emitters, or $4 \text{ E}3 \text{ Bq/cm}^2$ ($0.1 \text{ } \mu\text{Ci/cm}^2$) for all other alpha emitters; and

The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $4 \text{ E}4 \text{ Bq/cm}^2$ ($1.0 \text{ } \mu\text{Ci/cm}^2$) for beta and gamma and low toxicity alpha emitters, or $4 \text{ E}3 \text{ Bq/cm}^2$ ($0.1 \text{ } \mu\text{Ci/cm}^2$) for all other alpha emitters.

SCO-II: A solid object on which the limits for SCO-1 are exceeded and on which:

The non-fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed 400 Bq/cm^2 ($10^{-2} \text{ } \mu\text{Ci/cm}^2$) or beta and gamma and low toxicity alpha emitters or 40 Bq/cm^2 ($10^{-3} \text{ } \mu\text{Ci/cm}^2$) for all other alpha emitters;

The fixed contamination on the accessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $8 \text{ E}5 \text{ Bq/cm}^2$ ($20 \text{ } \mu\text{Ci/cm}^2$) for beta and gamma and low toxicity alpha emitters, or $8 \text{ E}4 \text{ Bq/cm}^2$ ($2 \text{ } \mu\text{Ci/cm}^2$) for all other alpha emitters;

The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2 (or the area of the surface if less than 300 cm^2) does not exceed $8 \text{ E}5 \text{ Bq/cm}^2$ ($20 \text{ } \mu\text{Ci/cm}^2$) for beta and gamma and low toxicity alpha emitters, or $8 \text{ E}4 \text{ Bq/cm}^2$ ($2 \text{ } \mu\text{Ci/cm}^2$) for all other alpha emitters.

Transport index means the dimensionless number (rounded up to the next tenth) placed on the label of a package, to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined as follows:

For non-fissile material packages, the number determined by multiplying the maximum radiation level in millisievert (mSv) per hour at one meter (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at one meter (3.3 ft); or

For fissile material packages, the number determined by multiplying the maximum radiation level in millisievert per hour at one meter (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at one meter (3.3 ft), or, for criticality control purposes, the number obtained as described in 10 CFR Part 71.59, whichever is larger.

Type A quantity means a quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material or A_2 for normal form radioactive material, where A_1 and A_2 are given in Appendix A of this section, or may be determined by procedures described in Appendix A of this section.

Type B quantity means a quantity of radioactive material greater than a Type A quantity.

Uranium - natural, depleted, enriched

Natural uranium means uranium with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235, and the remainder by weight essentially uranium-238).

Depleted uranium means uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

Enriched Uranium means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

13-003 REQUIREMENT FOR LICENSE: Except as authorized in a general or specific license issued by the Agency, or as exempted in 180 NAC 13-004, no licensee may:

1. Deliver radioactive material to a carrier for transport; or
2. Transport radioactive material.

13-004 EXEMPTIONS

13-004.01 Common and contract carriers, freight forwarders, and warehouse workers which are subject to the requirements of the DOT in 49 CFR 170 through 189 or the U.S. Postal Service in the Postal Service Manual (Domestic Mail Manual), incorporated by reference, at 39 CFR 111.1 (1997) and attached hereto as Attachment 13-1, are exempt from the requirements of this section to the extent that they transport or store radioactive material in the regular course of their carriage for others or storage incident thereto. Common and contract carriers who are not subject to the requirements of the DOT or U.S. Postal Service are subject to 180 NAC 13-003 and other applicable requirements of these regulations.

13-004.02 Any physician licensed by the State of Nebraska to dispense drugs in the practice of medicine is exempt from 180 NAC 13-003 with respect to transport by the physician of radioactive material for use in the practice of medicine. However, any physician operating under this exemption must be licensed under 180 NAC 3.

13-004.03 Any licensee is exempt from the requirements of this section to the extent that the licensee delivers to a carrier for transport a package containing radioactive material having a specific activity not greater than 70 Bq/gm (0.002 μ Ci/g).

13-004.04 A licensee is exempt from all requirements of 180 NAC 13, other than 180 NAC 13-005 and 13-016, with respect to shipment or carriage of the following:

1. Packages containing no more than Type A quantities or radioactive material if the package contains no fissile material; or
2. A package containing radioactive materials that is low specific activity (LSA) material in group LSA-1, or surface contaminated objects (SCO) in group SCO-1.

13-005 TRANSPORTATION OF LICENSED MATERIAL

13-005.01 Each licensee who transports licensed material outside of the site of usage, as specified in the Agency license, or where transport is on public highways, or who delivers licensed material to a carrier for transport, must:

1. Comply with the applicable requirements, appropriate to the mode of transport, of the regulations of the DOT, particularly regulations of the DOT in the following areas:
 - a. Packaging - 49 CFR Part 173: Subparts A and B and I.
 - b. Marking and labeling - 49 CFR Part 172: Subpart D, §§ 172.400 through 172.407, §§ 172.436 through 172.440, and Subpart E.
 - c. Placarding - 49 CFR Part 172: Subpart F, especially §§ 172.500 through 172.519, 172.556, and Appendices B and C.
 - d. Accident Reporting - 49 CFR Part 171: §§ 171.15 and 171.16.
 - e. Shipping papers and emergency information - 49 CFR Part 172: Subparts C and G.
 - f. Hazardous material employee training - 49 CFR Part 172: Subpart H.
 - g. Hazardous material shipper/carrier registration - 49 CFR Part 107: Subpart G.
2. Also comply with applicable DOT regulations pertaining to the following modes of transportation:
 - a. Rail - 49 CFR Part 174: Subparts A through D and K.
 - b. Air - 49 CFR Part 175
 - c. Vessel - 49 CFR Part 176: Subparts A through F and M.
 - d. Public Highway - 49 CFR Part 177 and Parts 390 through 397.
3. Assure that any special instructions needed to safely open the package are sent to or have been made available to the consignee in accordance with 180 NAC 4-038.

13-005.02 If, for any reason, the regulations of the DOT are not applicable to a shipment of licensed material, the licensee must conform to the standards and requirements of 49 CFR Parts 170 through 189 appropriate to the mode of transport to the same extent as if the shipment was subject to the regulations.

13-006 GENERAL LICENSES FOR CARRIERS

13-006.01 A general license is hereby issued to any common or contract carrier not exempt under 180 NAC 13-004 to receive, possess, transport, and store radioactive material in the regular course of their carriage for others or storage incident thereto, provided the transportation and storage is in accordance with the applicable requirements, appropriate to the mode of transport, of the DOT insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting².

13-006.02 A general license is hereby issued to any private carrier to transport radioactive material, provided the transportation is in accordance with the applicable requirements, appropriate to the mode of transport, of the DOT insofar as such requirements relate to the loading and storage of packages, placarding of the transporting vehicle, and incident reporting.

²Notification of incidents must be filed with, or made to, the Agency as prescribed in 49 CFR, regardless of and in addition to notification made to DOT or other agencies.

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13-006.03 Persons who transport radioactive material pursuant to the general licenses in 180 NAC 13-006.01 or 13-006.02 are exempt from the requirements of 180 NAC 4 and 10 to the extent that they transport radioactive material.

13-007 GENERAL LICENSE: U.S. NUCLEAR REGULATORY COMMISSION NRC APPROVED PACKAGES

13-007.01 A general license is hereby issued to any licensee to transport, or to deliver to a carrier for transport, licensed material in a package for which a license, certificate of compliance, or other approval has been issued by the NRC.

13-007.02 This general license applies only to a licensee who:

1. Has a copy of the specific license, certificate of compliance, or other approval by the NRC of the package and has the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment;
2. Complies with the terms and conditions of the license, certificate, or other approval by the NRC, as applicable, and the applicable requirements of 180 NAC 13;
3. Prior to the licensee's first use of the package, has registered with the NRC; and
4. Has a quality assurance program required by 180 NAC 13-021.

13-007.03 The general license in 180 NAC 13-007.01 applies only when the package approval authorizes use of the package under this general license.

13-007.04 For a Type B or fissile material package, the design of which was approved before April 1, 1996 the general license is subject to the additional restrictions of 180 NAC 13-008.

13-008 GENERAL LICENSE: PREVIOUSLY APPROVED PACKAGES

13-008.01 A Type B package previously approved by the NRC, but not designated as B(U) or B(M) in the identification number of the NRC Certificate of Compliance, may be used under the general license of 180 NAC 13-007 with the following additional conditions:

1. Fabrication of the packaging was satisfactorily completed before August 31, 1986, as demonstrated by application of its model number in accordance with NRC regulations at 10 CFR 71.85(c);
2. A package used for a shipment to a location outside the United States is subject to multilateral approval, as defined in DOT regulations at 49 CFR 173.403; and
3. A serial number that uniquely identifies each packaging which conforms to the approved design is assigned to, and legibly and durably marked on, the outside of each packaging.

13-008.02 A Type B(U) package, a Type B(M) package, a low specific activity (LSA) material package or a fissile material package, previously approved by the NRC but without the designation "-85" in the identification number of the NRC Certificate of Compliance, may be used under the general license of 180 NAC 13-007 with the following additional conditions:

1. Fabrication of the package is satisfactorily completed by April 1, 1996, as demonstrated by application of its model number in accordance with NRC regulations at 10 CFR 71.85(c).

2. A package used for a shipment to a location outside the United States is subject to multilateral approval except approved under special arrangement in accordance with DOT regulations at 49 CFR 173.403; and
3. A serial number which uniquely identifies each packaging which conforms to the approved design is assigned to, and legibly and durably marked on, the outside of each packaging.

13-009 GENERAL LICENSE: DOT SPECIFICATION CONTAINER

13-009.01 A general license is issued to any licensee to transport, or to deliver to a carrier for transport, licensed material in a specification container for fissile material or for a Type B quantity of radioactive material as specified in 49 CFR Parts 173 and 178.

13-009.02 This general license applies only to a licensee who:

1. Has a copy of the specification;
2. Complies with the terms and conditions of the specification and the applicable requirements of 180 NAC 13; and
3. Has a quality assurance program required by 180 NAC 13-021.

13-009.03 The general license in 180 NAC 13-009.01 is subject to the limitation that the specification container may not be used for a shipment to a location outside the United States except by multilateral approval as defined in 49 CFR 173.403.

13-010 GENERAL LICENSE: USE OF FOREIGN APPROVED PACKAGE

13-010.01 A general license is issued to any licensee to transport, or to deliver to a carrier for transport, licensed material in a package the design of which has been approved in a foreign national competent authority certificate which has been revalidated by the DOT as meeting the applicable requirements of 49 CFR 171.12.

13-010.02 This general license applies only to international shipments.

13-010.03 This general license applies only to a licensee who:

1. Has a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate relating to the use and maintenance of the packaging and to the actions to be taken prior to shipment; and
2. Complies with the terms and conditions of the certificate and revalidation and with the applicable requirements of 180 NAC 13.
3. Has a quality assurance program approved by the Agency.

13-011 GENERAL LICENSE: FISSILE MATERIAL, LIMITED QUANTITY PER PACKAGE

13-011.01 A general license is hereby issued to any licensee to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped in accordance with this Subsection.

13-011.02 The general license applies only to a licensee who has a quality assurance program approved by the Agency.

13-011.03 Except as provided in 180 NAC 13-011.04, this general license applies only when a package contains no more than a Type A quantity of radioactive material, including only one of the following:

1. Up to 40 grams of uranium-235;
2. Up to 30 grams of uranium-233;
3. Up to 25 grams of the fissile radionuclides of plutonium, except that for encapsulated plutonium-beryllium neutron sources in special form, an A₁ quantity of plutonium may be present; or
4. A combination of fissile radionuclides in which the sum of the ratios of the amount of each radionuclide to the corresponding maximum amounts in 013.11C(1), (2) and (3) does not exceed unity.

13-011.04 For packages where fissile material is mixed with substances having an average hydrogen density greater than water, this general license applies only when a package contains no more than a Type A quantity of radioactive material, including one of the following:

1. Up to 29 grams of uranium-235;
2. Up to 18 grams of uranium-233;
3. Up to 18 grams of fissile radionuclides of plutonium, or
4. A combination of fissile radionuclides in which the sums of the ratios of the amount of each radionuclide to the corresponding maximum amounts in 180 NAC 13-011.04, item (1), (2) and (3) does not exceed unity.

13-011.05 Except for the beryllium contained within the special form plutonium-beryllium sources authorized in 180 NAC 13-011.07, this general license applies only when beryllium, graphite, or hydrogenous material enriched in deuterium is not present in quantities exceeding 0.1% of the fissile material mass.

13-011.06 Except as specified in 180 NAC 13-011.06, item 1. for encapsulated plutonium-beryllium sources, this general license applies only when, a package is labeled with a transport index not less than the number given by the following equation, where the package contains x grams of uranium-235, y grams of uranium-233, and z grams of the fissile radionuclides of plutonium:

$$\text{Minimum Transport Index} = (0.25x + 0.33y + 0.4z)$$

1. For a package in which the only fissile material is in the form of encapsulated plutonium-beryllium neutron sources in special form, the transport index based on criticality considerations may be taken as 0.025 times the number of grams of the fissile radionuclides of plutonium.
2. Packages which have a transport index greater than 10 are not authorized under the general license provisions of this 180 NAC 13-011.

13-012 GENERAL LICENSE: FISSILE MATERIAL, LIMITED MODERATOR PER PACKAGE

13-012.01 A general license is hereby issued to any licensee to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped in accordance with this subsection.

13-012.02 This general license applies only when all of the following requirements are met:

1. The package contains no more than a Type A quantity of radioactive material;
2. Neither beryllium nor hydrogenous material enriched in deuterium is present;
3. The total mass of graphite present does not exceed 7.7 times the total mass of uranium-235 plus plutonium;
4. Substances having a higher hydrogen density than water, for example certain hydrocarbon oils are not present, except that polyethylene may be used for packing or wrapping;
5. Uranium-233 is not present, and the amount of plutonium does not exceed 1 percent of the amount of uranium-235;
6. The amount of uranium-235 is limited as follows:
 - a. If the fissile radionuclides are not uniformly distributed, the maximum amount of uranium-235 per package may not exceed the value given in TABLE I of 180 NAC 13-012; or
 - b. If the fissile radionuclides are distributed uniformly, for example, can not form a lattice arrangement within the packaging, the maximum amount of uranium-235 per package may not exceed the value given in TABLE II of 180 NAC 13-012; and
7. The transport index of each package based on criticality considerations is taken as 10 times the number of grams of uranium-235 in the package divided by the maximum allowable number of grams per package in accordance with TABLE I or TABLE II 180 NAC 13-012 as applicable.

13-012.03 Has a quality assurance program approved by the Agency.

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TABLE I - Permissible Mass of Uranium-235
Per Fissile Material Package
[Nonuniform Distribution]

Uranium enrichment in weight percent of uranium-235 not exceeding	Permissible maximum grams of uranium-235 per package
24	40
20	42
15	45
11	48
10	51
9.5	52
9	54
8.5	55
8	57
7.5	59
7	60
6.5	62
6	65
5.5	68
5	72
4.5	76
4	80
3.5	88
3	100
2.5	120
2	164
1.5	272
1.35	320
1	680*

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0.92	1,200*
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TABLE II - Permissible Mass of Uranium-235
Per Fissile Material Package
[Uniform Distribution]

Uranium enrichment in weight percent of uranium-235 not exceeding	Permissible maximum grams of uranium-235 per package
4	84
3.5	92
3	112
2.5	148
2	240
1.5	560*
1.35	800*

*Pursuant to the Agency's agreement with the NRC, jurisdiction extends only to 350 grams of uranium-235.

13-013 ASSUMPTIONS AS TO UNKNOWN PROPERTIES

When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other pertinent property of fissile material in any package is not known, the licensee must package the fissile material as if the unknown properties have credible values that will cause the maximum neutron multiplication.

13-014 PRELIMINARY DETERMINATIONS

Prior to the first use of any packaging for the shipment of radioactive material:

13-014.01 The licensee must ascertain that there are no defects which could significantly reduce the effectiveness of the packaging;

13-014.02 Where the maximum normal operating pressure will exceed 35 kilopascal (5lbf/in²) gauge, the licensee must test the containment system at an internal pressure at least 50% higher than the maximum normal operating pressure to verify the capability of that system to maintain its structural integrity at that pressure;

13-014.03 The licensee must determine that the packaging has been fabricated in accordance with the design approved by the NRC; and

13-014.04 The licensee must conspicuously and durably mark the packaging with its model number, serial number, gross weight, and a package identification number assigned by the NRC.

13-015 ROUTINE DETERMINATIONS: Prior to each shipment of licensed material, the licensee must determine that:

13-015.01 The package is proper for the contents to be shipped;

13-015.02 The package is in unimpaired physical condition except for superficial defects such as marks or dents;

13-015.03 Each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;

13-015.04 Any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;

13-015.05 Any pressure relief device is operable and set in accordance with written procedures;

13-015.06 The package has been loaded and closed in accordance with written procedures;

13-015.07 Any structural part of the package which could be used to lift or tie down the package during transport is rendered inoperable for that purpose unless it satisfies design requirements specified in 10 CFR 71.45;

13-015.08 The level of removable radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable. The level of removable radioactive contamination may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements must be taken in the most appropriate locations to yield a representative assessment of the removable contamination levels. Except as provided in 180 NAC 13-015.08, item (1), the amount of radioactivity measured on any single wiping material, when averaged over the surface wiped, must not exceed the limits given in TABLE I of 180 NAC 13-015 at any time during transport. Other methods of assessment of equal or greater efficiency may be used. When other methods are used, the detection efficiency of the method used must be taken into account and in no case may the removable contamination on the external surfaces of the package exceed 10 times the limits listed in TABLE I of 180 NAC 13-015.

1. In the case of packages transported as exclusive use shipments by rail or highway only, the removable radioactive contamination at any time during transport must not exceed 10 times the levels prescribed in 180 NAC 13-015.08. The levels at the beginning of transport must not exceed the levels in 180 NAC 13-015.08;

13-015.09 External radiation levels around the package and around the vehicle, if applicable, will not exceed 2 mSv/h (200 mrem/hr) at any point on the external surface of the package at any time during transportation. The transport index must not exceed 10.;

13-015.10 For a package transported in exclusive use by rail, highway or water, radiation levels external to the package may exceed the limits specified in 180 NAC 13-015.09 but must not exceed any of the following:

1. 2 mSv/h (200 mrem/hr) on the accessible external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1000 mrem/hr);

- a. The shipment is made in a closed transport vehicle,
 - b. Provisions are made to secure the package so that its position within the vehicle remains fixed during transportation, and
 - c. There are no loading or unloading operations between the beginning and end of the transportation.
2. 2 mSv/h (200 mrem/hr) at any point on the outer surface of the vehicle, including the upper and top and underside of the vehicle, or, in the case of a flat-bed style vehicle, with a personnel barrier*, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load [or enclosure, if used], and on the lower external surface of the vehicle³ ;
 3. 0.1 mSv/h (10 mrem/hr) at any point 2 meters from the vertical planes represented by the outer lateral surfaces of the vehicle, or, in the case of a flat-bed style vehicle, at any point 2 meters from the vertical planes projected from the outer edges of the vehicle; and
 4. 0.02 mSv/h (2 mrem/hr) in any normally occupied positions of the vehicle, except that this provision does not apply to private motor carriers when persons occupying these positions are provided with special health supervision, personnel radiation exposure monitoring devices, and training in accordance with 180 NRC 10-003; and

13-015.11 A package must be prepared for transport so that in still air at 100 degrees Fahrenheit (38 degrees Celsius) and in the shade, no accessible surface of a package would have a temperature exceeding 122 degrees Fahrenheit (50 degrees Celsius) in a nonexclusive use shipment or 185 degrees Fahrenheit (85 degrees Celsius) in an exclusive use shipment. Accessible package surface temperatures must not exceed these limits at any time during transportation.

13-015.12 A package may not incorporate a feature intended to allow continuous venting during transport.

³A flat-bed style vehicle with a personnel barrier must have radiation levels determined at vertical planes. If no personnel barrier, the package cannot exceed 2 mSv/h (200 mrem/hr) at the surface.*

TABLE I
Removable External Radioactive Contamination Wipe Limits

Contaminant	Maximum	Permissible	Limits
	Bq/cm ²	μCi/cm ²	dpm/cm ²
Beta and gamma emitters and low toxicity alpha emitters	0.41	1.0 E-5	22
All other alpha emitting radionuclides	0.04	1.0 E-6	2.2

13-016 AIR TRANSPORT OF PLUTONIUM

Notwithstanding the provisions of any general licenses and notwithstanding any exemptions stated directly in this Section or included indirectly by citation of the DOT regulations, as may be applicable, the licensee must assure that plutonium in any form is not transported by air, or delivered to a carrier for air transport, unless:

13-016.01 The plutonium is contained in a medical device designed for individual human application;

13-016.02 The plutonium is contained in a material in which the specific activity is not greater than 70 Bq/g (0.002 μCi/g) of material and in which the radioactivity is essentially uniformly distributed; or

13-016.03 The plutonium is shipped in a single package containing no more than an A₂ quantity of plutonium in any isotope or form and is shipped in accordance with 180 NAC 13-005; or

13-016.04 The plutonium is shipped in a package specifically authorized for the shipment of plutonium by air in the Certificate of Compliance for that package issued by the NRC; or

13-016.05 For a shipment of plutonium by air which is subject to 180 NAC 13-015.04, the licensee must, through special arrangement with the carrier, require compliance with 49 CFR 175.704, the DOT regulations applicable to the air transport of plutonium.

13-017 OPENING INSTRUCTIONS: Before delivery of a package to a carrier for transport, the licensee must ensure that any special instructions needed to safely open the package have been sent to, or otherwise made available to, the consignee for the consignee's use in accordance with 180 NAC 4-038.

13-018 SHIPMENT RECORDS: Each licensee must maintain for a period of three years after shipment a record of each shipment of licensed material not exempt under 180 NAC 13-004, showing, where applicable:

1. Identification of the packaging by model number and serial number;

2. Verification that the packaging, as shipped, has no significant defects;
3. Volume and identification of coolant;
4. Type and quantity of licensed material in each package, and the total quantity of each shipment;
5. Date of the shipment;
6. Name and address of the transferee;
7. Address to which the shipment was made; and
8. Results of the determinations required by 180 NAC 13-015 and by the conditions of the package approval.

13-019 REPORTS

The licensee must report to the Agency within 30 days:

1. Any instance in which there is significant reduction in the effectiveness of any packaging during use;
2. Details of any defects with safety significance in the packaging after first use, with the means employed to repair the defects and prevent their recurrence; or
3. Instances in which the conditions of approval in the Certificate of Compliance were not observed in making a shipment.

13-020 ADVANCE NOTIFICATION OF TRANSPORT OF NUCLEAR WASTE

13-020.01 Prior to the transport of any nuclear waste outside of the confines of the licensee's facility or other place of use or storage, or prior to the delivery of any nuclear waste to a carrier for transport, each licensee must provide advance notification of such transport to the governor, or governor's designee,* of each state within or through which the waste will be transported.⁴

13-020.02 Advance notification is required only when:

1. The nuclear waste is required to be in Type B packaging for transportation;
2. The nuclear waste is being transported into, within, or through, a state enroute to a disposal facility or to a collection point for transport to a disposal facility; and
3. The quantity of licensed material in a single package exceeds:

⁴A list of the mailing addresses of the governors and governors' designees is available upon request from the Director, Office of State Programs, NRC, Washington, D.C. 20555. The list will be published annually in the Federal register on or about June 30 to reflect any changes in information.

- a. 3000 times the A_1 value of the radionuclides as specified in Appendix 13-A, Table I for special form radioactive material;
- b. 3000 times the A_2 value of the radionuclides as specified in Appendix 13-A, Table I for normal form radioactive material; or
- c. 1000 TBq (27,000 Ci).

13-020.03 Each advance notification required by 180 NAC 13-020.01 must contain the following information:

1. The name, address, and telephone number of the shipper, carrier, and receiver of the shipment;
2. A description of the nuclear waste contained in the shipment as required by 49 CFR 172.202 and 172.203(d);
3. The point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;
4. The seven-day period during which arrival of the shipment at state boundaries is estimated to occur;
5. The destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and
6. A point of contact with a telephone number for current shipment information.

13-020.04 The notification required by 180 NAC 13-020.01 must be made in writing to the office of each appropriate governor, or governor's designee, and to the Agency. A notification delivered by mail must be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur. A notification delivered by messenger must reach the office of the governor, or governor's designee, at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur. A copy of the notification must be retained by the licensee for one year.

13-020.05 The licensee must notify each appropriate governor, or governor's designee, and the Agency of any changes to schedule information provided pursuant to 180 NAC 13-020.01. Such notification must be by telephone to a responsible individual in the office of the governor, or governor's designee, of the appropriate state or states. The licensee must maintain for one year a record of the name of the individual contacted.

13-020.06 Each licensee who cancels a nuclear waste shipment, for which advance notification has been sent, must send a cancellation notice, identifying the advance notification that is being canceled, to the governor, or governor's designee, of each appropriate state and to the Agency. A copy of the notice must be retained by the licensee for one year.

13-021 QUALITY ASSURANCE REQUIREMENTS

13-021.01 Unless otherwise authorized by the Agency, each licensee must establish, maintain, and execute a quality assurance program to verify by procedures such as checking, auditing, and inspection that deficiencies, deviations, and defective material and equipment relating to the shipment of packages containing radioactive material are promptly identified and corrected.

13-021.02 The licensee must identify the material and components to be covered by the quality assurance program.

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13-021.03 Each licensee must document the quality assurance program by written procedures or instructions and must carry out the program in accordance with those procedures throughout the period during which packaging is used.

13-021.04 Prior to the use of any package for the shipment of radioactive material, each licensee must obtain approval by the Agency of its quality assurance program.

13-021.05 The licensee must maintain sufficient written records to demonstrate compliance with the quality assurance program. Records of quality assurance pertaining to the use of a package for shipment of radioactive material must be maintained for a period of three years after shipment.

APPENDIX 13-A

DETERMINATION OF A₁ AND A₂

- I. Values of A₁ and A₂ for individual radionuclides, which are the bases for many activity limits elsewhere in these regulations are given in Table A-1. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) figure. The curie values are expressed to three significant figures to assure that the difference in the TBq and Ci quantities is one tenth of one percent or less. Where values of A₁ or A₂ are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.
- II. For individual radionuclides whose identities are known, but which are not listed in Table A-1, the determination of the values of A₁ and A₂ requires Department approval, except that the values of A₁ and A₂ in Table A-2 may be used without obtaining Agency Approval.
- III. In the calculations of A₁ and A₂ for a radionuclide not in Table A-1, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions, and in which no daughter nuclide has a half-life either longer than 10 days, or longer than that of the parent nuclide, must be considered as a single radionuclide, and the activity to be taken into account, and the A₁ and A₂ value to be applied must be those corresponding to the parent nuclide of that chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days, or greater than that of the parent nuclide, the parent and those daughter nuclides must be considered as mixtures of different nuclides.
- IV. For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply:
 - (a) For special form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_1(i)} \text{ Less than or equal to } 1$$

- (b) For normal form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{B(i)}{A_2(i)} \text{ Less than or equal to } 1$$

Where B(i) is the activity of radionuclide (i) and A₁ (i) and A₂ (i) are the A₁ and A₂ values for radionuclide i, respectively.

Alternatively, an A₁ value for **mixtures of special form** material may be determined as follows:

$$A_1 = \frac{1}{\sum_i \frac{f(i)}{A_1(i)}}$$

APPENDIX 13-A

Where $f(i)$ is the fraction of activity of nuclide i in the mixture and $A_2(i)$ is the appropriate A_2 value for nuclide (i) .

An A value for **mixtures of normal form material** may be determined as follows:

$$A_2 = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

Where $f(i)$ is the fraction of activity of nuclide (i) in the mixture and $A_2(i)$ is the appropriate A_2 value for nuclide i .

When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in paragraph IV. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters and beta/gamma emitters.

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Ac-225	Actinium (89)	0.6	16.2	1 E-2	0.270	2.1 E+3	5.8 E+4
Ac-227		40	1080	2 E-5	5.41 E-4	2.7	7.2 E+1
Ac-228		0.6	16.2	0.4	10.8	8.4 E+4	2.2 E+6
Ag-105	Silver (47)	2	54.1	2	54.1	1.1 E+3	3.0 E+4
Ag-108m		0.6	16.2	0.6	16.2	9.7 E-1	2.6 E+1
Ag-110m		0.4	10.8	0.4	10.8	1.8 E+2	4.7 E+3
Ag-111		0.6	16.2	0.5	13.5	5.8 E+3	1.6 E+5
Al-26	Aluminum (13)	0.4	10.8	0.4	10.8	7.0 E-4	1.9 E-2
Am-241	Americium (95)	2	54.1	2 E-4	5.41 E-3	1.3 E-1	3.4
Am-242m		2	54.1	2 E-4	5.41 E-3	3.6 E-1	1.0 E+1
Am-243		2	54.1	2 E-4	5.41 E-3	7.4 E-3	2.0 E-1
Ar-37	Argon (18)	40	1080	40	1080	3.7 E+3	9.9 E+4
Ar-39		20	541	20	541	1.3	3.4 E+1
Ar-41		0.6	16.2	0.6	16.2	1.5 E+6	4.2 E+7
Ar-42		0.2	5.41	0.2	5.41	9.6	2.6 E+2
As-72	Arsenic (33)	0.2	5.41	0.2	5.41	6.2 E+4	1.7 E+6
As-73		40	1080	40	1080	8.2 E+2	2.2 E+4
As-74		1	27	0.5	13.5	3.7 E+3	9.9 E+4
As-76		0.2	5.41	0.2	5.41	5.8 E+4	1.6 E+6
As-77		20	541	0.5	13.5	3.9 E+4	1.0 E+6
At-211	Astatine (85)	30	811	2	54.1	7.6 E+4	2.1 E+6
Au-193	Gold (79)	6	162	6	162	3.4 E+4	9.2 E+5
Au-194		1	27	1	27.0	1.5 E+4	4.1 E+5
Au-195		10	270	10	270	1.4 E+2	3.7 E+3
Au-196		2	54.1	2	54.1	4.0 E+3	1.1 E+5
Au-198		3	81.1	0.5	13.5	9.0 E+3	2.4 E+5
Au-199		10	270	0.9	24.3	7.7 E+3	2.1 E+5
Ba-131	Barium (56)	2	54.1	2	54.1	3.1 E+3	8.4 E+4
Ba-133m		10	270	0.9	24.3	2.2 E+4	6.1 E+5
Ba-133		3	81.1	3	81.1	9.4	2.6 E+2
Ba-140		0.4	10.8	0.4	10.8	2.7 E+3	7.3 E+4
Be-7	Beryllium (4)	20	541	20	541	1.3 E+4	3.5 E+5
Be-10		20	541	0.5	13.5	8.3 E-4	2.2 E-2
Bi-205	Bismuth (83)	0.6	16.2	0.6	16.2	1.5 E-3	4.2 E+4
Bi-206		0.3	8.11	0.3	8.11	3.8 E+3	1.0 E+5
Bi-207		0.7	18.9	0.7	18.9	1.9	5.2 E+1
Bi-210m		0.3	8.11	3 E-2	0.811	2.1 E-5	5.7 E-4
Bi-210		0.6	16.2	0.5	13.5	4.6 E+3	1.2 E+5
Bi-212		0.3	8.11	0.3	8.11	5.4 E+5	1.5 E+7
Bk-247	Berkelium (97)	2	54.1	2 E-4	5.41 E-3	3.8 E-2	1.0
Bk-249		40	1080	8 E-2	2.16	6.1 E+1	1.6 E+3
Br-76	Bromine (35)	0.3	8.11	0.3	8.11	9.4 E+4	2.5 E+6

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Br-77		3	81.1	3	81.1	2.6 E+4	7.1 E+5
Br-82		0.4	10.8	0.4	10.8	4.0 E+4	1.1 E+6
C-11	Carbon (6)	1	27	0.5	13.5	3.1 E+7	8.4 E+8
C-14		40	1080	2	54.1	1.6 E-1	4.5
Ca-41	Calcium (20)	40	1080	40	1080	3.1 E-3	8.5 E-2
Ca-45		40	1080	0.9	24.3	6.6 E+2	1.8 E+4
Ca-47		0.9	24.3	0.5	13.5	2.3 E+4	6.1 E+5
Cd-109	Cadmium (48)	40	1080	1	27.0	9.6 E+1	2.6 E+3
Cd-113m		20	541	9 E-2	2.43	8.3	2.2 E+2
Cd-115m		0.3	8.11	0.3	8.11	9.4 E+2	2.5 E+4
Cd-115		4	108	0.5	13.5	1.9 E+4	5.1 E+5
Ce-139	Cerium (58)	6	162	6	162	2.5 E+2	6.8 E+3
Ce-141		10	270	0.5	13.5	1.1 E+3	2.8 E+4
Ce-143		0.6	16.2	0.5	13.5	2.5 E+4	6.6 E+5
Ce-144		0.2	5.41	0.2	5.41	1.2 E+2	3.2 E+3
Cf-248	Californium (98)	30	811	3 E-3	8.11 E-2	5.8 E+1	1.6 E+3
Cf-249		2	54.1	2 E-4	5.41 E-3	1.5 E-1	4.1
Cf-250		5	135	5 E-4	1.35 E-2	4.0	1.1 E+2
Cf-251		2	54.1	2 E-4	5.41 E-3	5.9 E-2	1.6
Cf-252		0.1	2.70	1 E-3	2.70 E-2	2.0 E+1	5.4 E+2
Cf-253		40	1080	6 E-2	1.62	1.1 E+3	2.9 E+4
Cf-254		3 E-3	8.11 E-2	6 E-4	1.62 E-2	3.1 E+2	8.5 E+3
Cl-36	Chlorine (17)	20	541	0.5	13.5	1.2 E-3	3.3 E-2
Cl-38		0.2	5.41	0.2	5.41	4.9 E+6	1.3 E+8
Cm-240	Curium (96)	40	1080	2 E-2	0.541	7.5 E+2	2.0 E+4
Cm-241		2	54.1	0.9	24.3	6.1 E+2	1.7 E+4
Cm-242		40	1080	1 E-2	0.270	1.2 E+2	3.3 E+3
Cm-243		3	81.1	3 E-4	8.11 E-3	1.9 E-3	5.2 E+1
Cm-244		4	108	4 E-4	1.08 E-2	3.0	8.1 E+1
Cm-245		2	54.1	2 E-4	5.41 E-3	6.4 E-3	1.7 E-1
Cm-246		2	54.1	2 E-4	5.41 E-3	1.1 E-2	3.1 E-1
Cm-247		2	54.1	2 E-4	5.41 E-3	3.4 E-6	9.3 E-5
Cm-248		4 E-2	1.08	5 E-5	1.35 E-3	1.6 E-4	4.2 E-3
Co-55	Cobalt (27)	0.5	13.5	0.5	13.5	1.1 E+5	3.1 E+6
Co-56		0.3	8.11	0.3	8.11	1.1 E+3	3.0 E+4
Co-57		8	216	8	216	3.1 E+2	8.4 E+3
Co-58m		40	1080	40	1080	2.2 E+5	5.9 E+6
Co-58		1	27	1	27.0	1.2 E+3	3.2E+4
Co-60		0.4	10.8	0.4	10.8	4.2 E+1	1.1 E+3
Cr-51	Chromium (24)	30	811	30	811	3.4 E+3	9.2 E+4
Cs-129	Cesium (55)	4	108	4	108	2.8 E+4	7.6 E+5
Cs-131		40	1080	40	1080	3.8 E+3	1.0 E+5

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Cs-132		1	27	1	27.0	5.7 E+3	1.5 E+5
Cs-134m		40	1080	9	243	3.0 E+5	8.0 E+6
Cs-134		0.6	16.2	0.5	13.5	4.8 E+1	1.3 E+3
Cs-135		40	1080	0.9	24.3	4.3 E-5	1.2 E-3
Cs-136		0.5	13.5	0.5	13.5	2.7 E+3	7.3 E+4
Cs-137		2	54.1	0.5	13.5	3.2	8.7 E+1
Cu-64	Copper (29)	5	135	0.9	24.3	1.4 E+5	3.9 E+6
Cu-67		9	243	0.9	24.3	2.8 E+4	7.6 E+5
Dy-159	Dysprosium (66)	20	541	20	541	2.1 E+2	5.7 E+3
Dy-165		0.6	16.2	0.5	13.5	3.0 E+5	8.2 E+6
Dy-166		0.3	8.11	0.3	8.11	8.6 E+3	2.3 E+5
Er-169	Erbium (68)	40	1080	0.9	24.3	3.1 E+3	8.3 E+4
Er-171		0.6	16.2	0.5	13.5	9.0 E+4	2.4 E+6
Es-253	Einsteinium (99)	200	5400	2 E-2	5.41 E-1		
Es-254		30	811	3 E-3	8.11 E-2		
Es-254m		0.6	16.2	0.4	10.8		
Es-255							
Eu-147	Europium (63)	2	54.1	2	54.1	1.4 E+3	3.7 E+4
Eu-148		0.5	13.5	0.5	13.5	6.0 E+2	1.6 E+4
Eu-149		20	541	20	541	3.5 E+2	9.4 E+3
Eu-150		0.7	18.9	0.7	18.9	6.1 E+4	1.6 E+6
Eu-152m		0.6	16.2	0.5	13.5	8.2 E+4	2.2 E+6
Eu-152		0.9	24.3	0.9	24.3	6.5	1.8 E+2
Eu-154		0.8	21.6	0.5	13.5	9.8	2.6 E+2
Eu-155		20	541	2	54.1	1.8 E+1	4.9 E+2
Eu-156		0.6	16.2	0.5	13.5	2.0 E+3	5.5 E+4
F-18	Fluorine (9)	1	27	0.5	13.5	3.5 E+6	9.5 E+7
Fe-52	Iron (26)	0.2	5.41	0.2	5.41	2.7 E+5	7.3 E+6
Fe-55		40	1080	40	1080	8.8 E+1	2.4 E+3
Fe-59		0.8	21.6	0.8	21.6	1.8 E+3	5.0 E+4
Fe-60		40	1080	0.2	5.41	7.4 E-4	2.0 E-2
Fm-255	Fermium (100)	40	1080	0.8	21.6		
Fm-257		10	270	8 E-3	2.16 E-1		
Ga-67	Gallium (31)	6	162	6	162	2.2 E+4	6.0 E+5
Ga-68		0.3	8.11	0.3	8.11	1.5 E+6	4.1 E+7
Ga-72		0.4	10.8	0.4	10.8	1.1 E+5	3.1 E+6
Gd-146	Gadolinium (64)	0.4	10.8	0.4	10.8	6.9 E+2	1.9 E+4
Gd-148		3	81.1	3 E-4	8.11 E-3	1.2	3.2 E+1
Gd-153		10	270	5	135	1.3 E+2	3.5 E+3
Gd-159		4	108	0.5	13.5	3.9 E+4	1.1 E+6
Ge-68	Germanium (32)	0.3	8.11	0.3	8.11	2.6 E+2	7.1 E+3

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Ge-71		40	1080	40	1080	5.8 E+3	1.6 E+5
Ge-77		0.3	8.11	0.3	8.11	1.3 E+5	3.6 E+6
H-3	Hydrogen (1)	See	Tritium				
Hf-172	Hafnium (72)	0.5	13.5	0.3	8.11	4.1 E+1	1.1 E+3
Hf-175		3	81.1	3	81.1	3.9 E+2	1.1 E+4
Hf-181		2	54.1	0.9	24.3	6.3 E+2	1.7 E+4
Hf-182		4	108	3 E-2	0.811	8.1 E-6	2.2 E-4
Hg-194	Mercury (80)	1	27	1	27.0	1.3 E-1	3.5
Hg-195m		5	135	5	135	1.5 E+4	4.0 E+5
Hg-197m		10	270	0.9	24.3	2.5 E+4	6.7 E+5
Hg-197		10	270	10	270	9.2 E+3	2.5 E+5
Hg-203		4	108	0.9	24.3	5.1 E+2	1.4 E+4
Ho-163	Holmium (67)	40	1080	40	1080	2.7	7.6 E+1
Ho-166m		0.6	16.2	0.3	8.11	6.6 E-2	1.8
Ho-166		0.3	8.11	0.3	8.11	2.6 E+4	7.0 E+5
I-123	Iodine (53)	6	162	6	162	7.1 E+4	1.9 E+6
I-124		0.9	24.3	0.9	24.3	9.3 E+3	2.5 E+5
I-125		20	541	2	54.1	6.4 E+2	1.7 E+4
I-126		2	54.1	0.9	24.3	2.9 E+3	8.0 E+4
I-129		Unlimited	Unlimited	Unlimited	Unlimited	6.5 E-6	1.8 E-4
I-131		3	81.1	0.5	13.5	4.6 E+3	1.2 E+5
I-132		0.4	10.8	0.4	10.8	3.8 E+5	1.0 E+7
I-133		0.6	16.2	0.5	13.5	4.2 E+4	1.1 E+6
I-134		0.3	8.11	0.3	8.11	9.9 E+5	2.7 E+7
I-135		0.6	16.2	0.5	13.5	1.3 E+5	3.5 E+6
In-111	Indium (49)	2	54.1	2	54.1	1.5 E+4	4.2 E+5
In-113m		4	108	4	108	6.2 E+5	1.7 E+7
In-114m		0.3	8.11	0.3	8.11	8.6 E+2	2.3 E+4
In-115m		6	162	0.9	24.3	2.2 E+5	6.1 E+6
Ir-189	Iridium (77)	10	270	10	270	1.9 E+3	5.2 E+4
Ir-190		0.7	18.9	0.7	18.9	2.3 E+3	6.2 E+4
Ir-192		1	27.0	0.5	13.5	3.4 E+2	9.2 E+3
Ir-193m		10	270	10	270	2.4 E+3	6.4 E+4
Ir-194		0.2	5.41	0.2	5.41	3.1 E+4	8.4 E+5
K-40	Potassium (19)	0.6	16.2	0.6	16.2	2.4 E-7	6.4 E-6
K-42		0.2	5.41	0.2	5.41	2.2 E+5	6.0 E+6
K-43		1.0	27	0.5	13.5	1.2 E+5	3.6 E+6
Kr-81	Krypton (36)	40	1080	40	1080	7.8 E-4	3.1 E-2
Kr-85m		6	162	6	162	3.0 E+5	8.2 E+6
Kr-85		20	541	10	270	1.5 E+1	3.9 E+2
Kr-87		0.2	5.41	0.2	5.41	1.0 E+6	2.8 E+7
La-137	Lanthanum (57)	40	1080	2	54.1	1.6 E-3	4.4 E-2

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
La-140		0.4	10.8	0.4	10.8	2.1 E+4	5.6 E+5
Lu-172	Lutetium (71)	0.5	13.5	0.5	13.5	4.2 E+3	1.1 E+5
Lu-173		8	216	8	216	5.6 E+1	1.5 E+3
Lu-174m		20	541	8	216	2.0 E+2	5.3 E+3
Lu-174		8	216	4	108	2.3 E+1	6.2 E+2
Lu-177		30	811	0.9	24.3	4.1 E+3	1.1 E+5
MFP	For mixed fission	products,	use	formula for	mixtures	or	Table A-3
Mg-28	Magnesium (12)	0.2	5.41	0.2	5.41	2.0 E+5	5.4 E+6
Mn-52	Manganese (25)	0.3	8.11	0.3	8.11	1.6 E+4	4.4 E+5
Mn-53		Unlimited	Unlimited	Unlimited	Unlimited	6.8 E-5	1.8 E-3
Mn-54		1.0	27	1	27.0	2.9 E+2	7.7 E+3
Mn-56		0.2	5.41	0.2	5.41	8.0 E+5	2.2 E+7
Mo-93	Molybdenum (42)	40	1080	7	189	4.1 E-2	1.1
Mo-99		0.6	16.2	0.5	13.5	1.8 E+4	4.8 E+5
N-13	Nitrogen (7)	0.6	16.2	0.5	13.5	5.4 E+7	1.5 E+9
Na-22	Sodium (11)	0.5	13.5	0.5	13.5	2.3 E+2	6.3 E+3
Na-24		0.2	5.41	0.2	5.41	3.2 E+5	8.7 E+6
Nb-92m	Niobium (41)	0.7	18.9	0.7	18.9	5.2 E+3	1.4 E+5
Nb-93m		40	1080	6	162	8.8	2.4 E+2
Nb-94		0.6	16.2	0.6	16.2	6.9 E-3	1.9 E-1
Nb-95		1	27	1	27.0	1.5 E+3	3.9 E+4
Nb-97		0.6	16.2	0.5	13.5	9.9 E+5	2.7 E+7
Nd-147	Neodymium (60)	4	108	0.5	13.5	3.0 E+3	8.1 E+4
Nd-149		0.6	16.2	0.5	13.5	4.5 E+5	1.2 E+7
Ni-59	Nickel (28)	40	1080	40	1080	3.0 E-3	8.0 E-2
Ni-63		40	1080	30	811	2.1	5.7 E+1
Ni-65		0.3	8.11	0.3	8.11	7.1 E+5	1.9 E+7
Np-235	Neptunium (93)	40	1080	40	1080	5.2 E+1	1.4 E+3
Np-236		7	189	1 E-3	2.70 E-2	4.7 E-4	1.3 E-2
Np-237		2	54.1	2 E-4	5.41 E-3	2.6 E-5	7.1 E-4
Np-239		6	162	0.5	13.5	8.6 E+3	2.3 E+5
Os-185	Osmium (76)	1	27	1	27.0	2.8 E+2	7.5 E+3
Os-191m		40	1080	40	1080	4.6 E+4	1.3 E+6
Os-191		10	270	0.9	24.3	1.6 E+3	4.4 E+4
Os-193		0.6	16.2	0.5	13.5	2.0 E+4	5.3 E+5
Os-194		0.2	5.41	0.2	5.41	1.1 E+1	3.1 E+2
P-32	Phosphorus (15)	0.3	8.11	0.3	8.11	1.1 E+4	2.9 E+5
P-33		40	1080	0.9	24.3	5.8 E+3	1.6 E+5
Pa-230	Protactinium (91)	2	54.1	0.1	2.70	1.2 E+3	3.3 E+4
Pa-231		0.6	16.2	6 E-5	1.62 E-3	1.7 E-3	4.7 E-2
Pa-233		5	135	0.9	24.3	7.7 E+2	2.1 E+4
Pb-201	Lead (Pb)	1	27	1	27.0	6.2 E+4	1.7 E+6

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Pb-202		40	1080	2	54.1	1.2 E-4	3.4 E-3
Pb-203		3	81.1	3	81.1	1.1 E+4	3.0 E+5
Pb-205		Unlimited	Unlimited	Unlimited	Unlimited	4.5 E-6	1.2 E-4
Pb-210		0.6	16.2	9 E-3	0.243	2.8	7.6 E+1
Pb-212		0.3	8.11	0.3	8.11	5.1 E+4	1.4 E+6
Pd-103	Palladium (46)	40	1080	40	1080	2.8 E+3	7.5 E+4
Pd-107		Unlimited	Unlimited	Unlimited	Unlimited	1.9 E-5	5.1 E-4
Pd-109		0.6	16.2	0.5	13.5	7.9 E+4	2.1 E+6
Pm-143	Promethium (61)	3	81.1	3	81.1	1.3 E+2	3.4 E+3
Pm-144		0.6	16.2	0.6	16.2	9.2 E+1	2.5 E+3
Pm-145		30	811	7	189	5.2	1.4 E+2
Pm-147		40	1080	0.9	24.3	3.4 E+1	9.3 E+2
Pm-148m		0.5	13.5	0.5	13.5	7.9 E+2	2.1 E+4
Pm-149		0.6	16.2	0.5	13.5	1.5 E+4	4.0 E+5
Pm-151		3	81.1	0.5	13.5	2.7 E+4	7.3 E+5
Po-208	Polonium (84)	40	1080	2 E-2	0.541	2.2 E+1	5.9 E+2
Po-209		40	1080	2 E-2	0.541	6.2 E-1	1.7 E+1
Po-210		40	1080	2 E-2	0.541	1.7 E+2	4.5 E+3
Pr-142	Praseodymium (59)	0.2	5.41	0.2	5.41	4.3 E+4	1.2 E+6
Pr-143		4	108	0.5	13.5	2.5 E+3	6.7 E+4
Pt-188	Platinum (78)	0.6	16.2	0.6	16.2	2.5 E+3	6.8 E+4
Pt-191		3	81.1	3	81.1	8.7 E+3	2.4 E+5
Pt-193m		40	1080	9	243	5.8 E+3	1.6 E+5
Pt-193		40	1080	40	1080	1.4	3.7 E+1
Pt-195m		10	270	2	54.1	6.2 E+3	1.7 E+5
Pt-197m		10	270	0.9	24.3	3.7 E+5	1.0 E+7
Pt-197		20	541	0.5	13.5	3.2 E+4	8.7 E+5
Pu-236	Plutonium (94)	7	189	7 E-4	1.89 E-2	2.0 E+1	5.3 E+2
Pu-237		20	541	20	541	4.5 E+2	1.2 E+4
Pu-238		2	54.1	2 E-4	5.41 E-3	6.3 E-1	1.7 E+1
Pu-239		2	54.1	2 E-4	5.41 E-3	2.3 E-3	6.2 E-2
Pu-240		2	54.1	2 E-4	5.41 E-3	8.4 E-3	2.3 E-1
Pu-241		40	1080	1 E-2	0.270	3.8	1.0 E+2
Pu-242		2	54.1	2 E-4	5.41 E-3	1.5 E-4	3.9 E-3
Pu-244		0.3	8.11	2 E-4	5.41 E-3	6.7 E-7	1.8 E-5
Ra-223	Radium (88)	0.6	54.1	3 E-2	0.811	1.9 E+3	5.1 E+4
Ra-224		0.3	8.11	6 E-2	1.62	5.9 E+3	1.6 E+5
Ra-225		0.6	16.2	2 E-2	0.541	1.5 E+3	3.9 E+4
Ra-226		0.3	8.11	2 E-2	0.541	3.7 E-2	1.0
Ra-228		0.6	16.2	4 E-2	1.08	1.0 E+1	2.7 E+2
Rb-81	Rubidium (37)	2	54.1	0.9	24.3	3.1 E+5	8.4 E+6
Rb-83		2	54.1	2	54.1	6.8 E+2	1.8 E+4

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Rb-84		1	27	0.9	24.3	1.8 E+3	4.7 E+4
Rb-86		0.3	8.11	0.3	8.11	3.0 E+3	8.1 E+4
Rb-87		Unlimited	Unlimited	Unlimited	Unlimited	3.2 E-9	8.6 E-8
Rb(natural)		Unlimited	Unlimited	Unlimited	Unlimited	6.7 E-10	1.8 E-8
Re-183	Rhenium (75)	5	135	5	135	3.8 E+2	1.0 E+4
Re-184m		3	81.1	3	81.1	1.6 E+2	4.3 E+3
Re-184		1	27	1	27.0	6.9 E+2	1.9 E+4
Re-186		4	108	0.5	13.5	6.9 E+3	1.9 E+5
Re-187		Unlimited	Unlimited	Unlimited	Unlimited	1.4 E-9	3.8 E-8
Re-188		0.2	5.41	0.2	5.41	3.6 E+4	9.8 E+5
Re-189		4	108	0.5	13.5	2.5 E+4	6.8 E+5
Re(natural)		Unlimited	Unlimited	Unlimited	Unlimited	8.8 E-10	2.4 E-8
Rh-99	Rhodium (45)	2	54.1	2	54.1	3.0 E+3	8.2 E+4
Rh-101		4	108	4	108	4.1 E+1	1.1 E+3
Rh-102m		2	54.1	0.9	24.3	2.3 E+2	6.2 E+3
Rh-102		0.5	13.5	0.5	13.5	4.5 E+1	1.2 E+3
Rh-103m		40	1080	40	1080	1.2 E+6	3.3 E+7
Rh-105		10	270	0.9	24.3	3.1 E+4	8.4 E+5
Rn-222	Radon (86)	0.2	5.41	4 E-3	0.108	5.7 E+3	1.5 E+5
Ru-97	Ruthenium (44)	4	108	4	108	1.7 E+4	4.6 E+5
Ru-103		2	54.1	0.9	24.3	1.2 E+3	3.2 E+4
Ru-105		0.6	16.2	0.5	13.5	2.5 E+5	6.7 E+6
Ru-106		0.2	5.41	0.2	5.41	1.2 E+2	3.3 E+3
S-35	Sulfur (16)	40	1080	2	54.1	1.6 E+3	4.3 E+4
Sb-122	Antimony (51)	0.3	8.11	0.3	8.11	1.5 E+4	4.0 E+5
Sb-124		0.6	16.2	0.5	13.5	6.5 E+2	1.7 E+4
Sb-125		2	54.1	0.9	24.3	3.9 E+1	1.0 E+3
Sb-126		0.4	10.8	0.4	10.8	3.1 E+3	8.4 E+4
Sc-44	Scandium (21)	0.5	13.5	0.5	13.5	6.7 E+5	1.8 E+7
Sc-46		0.5	13.5	0.5	13.5	1.3 E+3	3.4 E+4
Sc-47		9	243	0.9	24.3	3.1 E+4	8.3 E+5
Sc-48		0.3	8.11	0.3	8.11	5.5 E+4	1.5 E+6
Se-75	Selenium (34)	3	81.1	3	81.1	5.4 E+2	1.5 E+4
Se-79		40	1080	2	54.1	2.6 E-3	7.0 E-2
Si-31	Silicon (14)	0.6	16.2	0.5	13.5	1.4 E+6	3.9 E+7
Si-32		40	1080	0.2	5.41	3.9	1.1 E+2
Sm-145	Samarium (62)	20	541	20	541	9.8 E+1	2.6 E+3
Sm-147		Unlimited	Unlimited	Unlimited	Unlimited	8.5 E-10	2.3 E-8
Sm-151		40	1080	4	108	9.7 E-1	2.6 E+1
Sm-153		4	108	0.5	13.5	1.6 E+4	4.4 E+5
Sn-113	Tin (50)	4	108	4	108	3.7 E+2	1.0 E+4
Sn-117m		6	162	2	54.1	3.0 E+3	8.2 E+4

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Sn-119m		40	1080	40	1080	1.4 E+2	3.7 E+3
Sn-121m		40	1080	0.9	24.3	2.0	5.4 E+1
Sn-123		0.6	16.2	0.5	13.5	3.0 E+2	8.2 E+3
Sn-125		0.2	5.41	0.2	5.41	4.0 E+3	1.1 E+5
Sn-126		0.3	8.11	0.3	8.11	1.0 E-3	2.8 E-2
Sr-82	Strontium (38)	0.2	5.41	0.2	5.41	2.3 E-3	6.2 E+4
Sr-85m		5	135	5	135	1.2 E+6	3.3 E+7
Sr-85		2	54.1	2	54.1	8.8 E+2	2.4 E+4
Sr-87m		3	81.1	3	81.1	4.8 E+5	1.3 E+7
Sr-89		0.6	16.2	0.5	13.5	1.1 E+3	2.9 E+4
Sr-90		0.2	5.41	0.1	2.70	5.1	1.4 E+2
Sr-91		0.3	8.11	0.3	8.11	1.3 E+5	3.6 E+6
Sr-92		0.8	21.6	0.5	13.5	4.7 E+5	1.3 E+7
T	Tritium (1)	40	1080	40	1080	3.6 E+2	9.7 E+3
Ta-178	Tantalum (73)	1	27	1	27.0	4.2 E+6	1.1 E+8
Ta-179		30	811	30	811	4.1 E+1	1.1 E+3
Ta-182		0.8	21.6	0.5	13.5	2.3 E+2	6.2 E+3
Tb-157	Terbium (65)	40	1080	10	270	5.6 E-1	1.5 E+1
Tb-158		1	27	0.7	18.9	5.6 E-1	1.5 E+1
Tb-160		0.9	24.3	0.5	13.5	4.2 E+2	1.1 E+4
Tc-95m	Technetium (43)	2	54.1	2	54.1	8.3 E+2	2.2 E+4
Tc-96m		0.4	10.8	0.4	10.8	1.4 E+6	3.8 E+7
Tc-96		0.4	10.8	0.4	10.8	1.2 E+4	3.2 E+5
Tc-97m		40	1080	40	1080	5.6 E+2	1.5 E+4
Tc-97		Unlimited	Unlimited	Unlimited	Unlimited	5.2 E-5	1.4 E-3
Tc-98		0.7	18.9	0.7	18.9	3.2 E-5	8.7 E-4
Tc-99m		8	216	8	216	1.9 E+5	5.3 E+6
Tc-99		40	1080	0.9	24.3	6.3 E-4	1.7 E-2
Te-118	Tellurium (52)	0.2	5.41	0.2	5.41	6.8 E+3	1.8 E+5
Te-121m		5	135	5	135	2.6 E+2	7.0 E+3
Te-121		2	54.1	2	54.1	2.4 E+3	6.4 E+4
Te-123m		7	189	7	189	3.3 E+2	8.9 E+3
Te-125m		30	811	9	243	6.7 E+2	1.8 E+4
Te-127m		20	541	0.5	13.5	3.5 E+2	9.4 E+3
Te-127		20	541	0.5	13.5	9.8 E+4	2.6 E+6
Te-129m		0.6	16.2	0.5	13.5	1.1 E+3	3.0 E+4
Te-129		0.6	16.2	0.5	13.5	7.7 E+5	2.1 E+7
Te-131m		0.7	18.9	0.5	13.5	3.0 E+4	8.0 E+5
Te-132		0.4	10.8	0.4	10.8	1.1 E+4	3.0 E+5
Th-227	Thorium (90)	9	243	1 E-2	0.270	1.1 E+3	3.1 E+4
Th-228		0.3	8.11	4 E-4	1.08 E-2	3.0 E+1	8.2 E+2
Th-229		0.3	8.11	3 E-5	8.11 E-4	7.9 E-3	2.1 E-1

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Th-230		2	54.1	2 E-4	5.41 E-3	7.6 E-4	2.1 E-2
Th-231		40	1080	0.9	24.3	2.0 E+4	5.3 E+5
Th-232		Unlimited	Unlimited	Unlimited	Unlimited	4.0 E-9	1.1 E-7
Th-234		0.2	5.41	0.2	5.41	8.6 E+2	2.3 E+4
Th(natural)		Unlimited	Unlimited	Unlimited	Unlimited	8.1 E-9	2.2 E-7
Ti-44	Titanium (22)	0.5	13.5	0.2	5.41	6.4	1.7 E+2
Tl-200	Thallium (81)	0.8	21.6	0.8	21.6	2.2 E+4	6.0 E+5
Tl-201		10	270	10	270	7.9 E+3	2.1 E+5
Tl-202		2	54.1	2	54.1	2.0 E+3	5.3 E+4
Tl-204		4	108	0.5	13.5	1.7 E+1	4.6 E+2
Tm-167	Thulium (69)	7	189	7	189	3.1 E+3	8.5 E+4
Tm-168		0.8	21.6	0.8	21.6	3.1 E+2	8.3 E+3
Tm-170		4	108	0.5	13.5	2.2 E+2	6.0 E+3
Tm-171		40	1080	10	270	4.0 E+1	1.1 E+3
U-230	Uranium (92)	40	1080	1 E-2	0.270	1.0 E+3	2.7 E+4
U-232		3	81.1	3 E-4	8.11 E-3	8.3 E-1	2.2 E+1
U-233		10	270	1 E-3	2.70 E-2	3.6 E-4	9.7 E-3
U-234		10	270	1 E-3	2.70 E-2	2.3 E-4	6.2 E-3
U-235		Unlimited	Unlimited	Unlimited	Unlimited	8.0 E-8	2.2 E-6
U-236		10	270	1 E-3	2.70 E-2	2.4 E-6	6.5 E-5
U-238		Unlimited	Unlimited	Unlimited	Unlimited	1.2 E-8	3.4 E-7
U (natural)		Unlimited	Unlimited	Unlimited	Unlimited	2.6 E-8	7.1 E-7
U(enriched 5% or less)		Unlimited	Unlimited	Unlimited	Unlimited	(See Table A-3)	
U(enriched more than 5%)		10	270	1 E-3	2.70 E-2	(See Table A-3)	
U(depleted)		Unlimited	Unlimited	Unlimited	Unlimited	(See Table A-3)	
V-48	Vanadium (23)	0.3	8.11	0.3	8.11	6.3 E+3	1.7 E+5
V-49		40	1080	40	1080	3.0 E+2	8.1 E+3
W-178	Tungsten (74)	1	27	1	27.0	1.3 E+3	3.4 E+4
W-181		30	811	30	811	2.2 E+2	6.0 E+3
W-185		40	1080	0.9	24.3	3.5 E+2	9.4 E+3
W-187		2	54.1	0.5	13.5	2.6 E+4	7.0 E+5
W-188		0.2	5.41	0.2	5.41	3.7 E+2	1.0 E+4
Xe-122	Xenon (54)	0.2	5.41	0.2	5.41	4.8 E+4	1.3 E+6
Xe-123		0.2	5.41	0.2	5.41	4.4 E+5	1.2 E+7
Xe-127		4	108	4	108	1.0 E+3	2.8 E+4
Xe-131m		40	1080	40	1080	3.1 E+3	8.4 E+4
Xe-133		20	541	20	541	6.9 E+3	1.9 E+5
Xe-135		4	108	4	108	9.5 E+4	2.6 E+6
Y-87	Yttrium (39)	2	54.1	2	54.1	1.7 E+4	4.5 E+5
Y-88		0.4	10.8	0.4	10.8	5.2 E+2	1.4 E+4
Y-90		0.2	5.41	0.2	5.41	2.0 E+4	5.4 E+5
Y-91m		2	54.1	2	54.1	1.5 E+6	4.2 E+7

TABLE A-1: A₁ AND A₂ VALUES FOR RADIONUCLIDES

Symbol of	Element and	A ₁ (TBq)	A ₁ (Ci)	A ₂ (TBq)	A ₂ (Ci)	Specific	Activity
Radionuclides	Atomic Number					(TBq/g)	(Ci/g)
Y-91		0.3	8.11	0.3	8.11	9.1 E+2	2.5 E+4
Y-92		0.2	5.41	0.2	5.41	3.6 E+5	9.6 E+6
Y-93		0.2	5.41	0.2	5.41	1.2 E+5	3.3 E+6
Yb-169	Ytterbium (70)	3	81.1	3	81.1	8.9 E+2	2.4 E+4
Yb-175		30	811	0.9	24.3	6.6 E+3	1.8 E+5
Zn-65	Zinc (30)	2	54.1	2	54.1	3.0 E+2	8.2 E+3
Zn-69m		2	54.1	0.5	13.5	1.2 E+5	3.3 E+6
Zn-69		4	108	0.5	13.5	1.8 E+6	4.9 E+7
Zr-88	Zirconium (40)	3	81.1	3	81.1	6.6 E+2	1.8 E+4
Zr-93		40	1080	0.2	5.41	9.3 E-5	2.5 E-3
Zr-95		1	27	0.9	24.3	7.9 E+2	2.1 E+4
Zr-97		0.3	8.11	0.3	8.11	7.1 E+4	1.9 E+6

TABLE A-2: GENERAL VALUES FOR A_1 AND A_2

CONTENTS	A_1		A_2	
	TBq	Ci	TBq	Ci
Only beta- or gamma-emitting nuclides are known to be present	0.2	5	0.02	0.5
Alpha-emitting nuclides are known to be present, or no relevant data are available	0.10	2.70	2 E-5	5.4 E-4

TABLE A-3: ACTIVITY-MASS RELATIONSHIPS FOR URANIUM

Uranium Enrichment*- weight % U-235 present	Specific Activity	
	Ci/g	TBq/g
0.45	1.8 E-8	5.0 E-7
0.72	2.6 E-8	7.1 E-7
1.0	2.8 E-8	7.6 E-7
15	3.7 E-8	1.0 E-6
5.0	1.0 E-7	2.7 E-6
10.0	1.8 E-7	4.8 E-6
20.0	3.7 E-7	1.0 E-5
35.0	7.4 E-7	2.0 E-5
50.0	9.3 E-7	2.5 E-5
90.0	2.2 E-6	5.8 E-5
93.0	2.6 E-6	7.0 E-5
95.0	3.4 E-6	9.1 E-5

* The figures for uranium include representative values for the activity of the uranium-234 which is concentrated during the enrichment process.

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NOTE: Copies of 49 CFR Part 107, 49 CFR Part 170 through 189, 49 CRF Part 390 through 397 may be obtained from:

**U.S. Government Printing Office
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ATTACHMENT 13-1

39 CFR Part 111, §111.1

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SUBCHAPTER C—POST OFFICE SERVICES [DOMESTIC MAIL]

General Information on Postal
Service

**PART 111—GENERAL INFORMATION
ON POSTAL SERVICE**

Sec.

- 111.1 Domestic Mail Manual; incorporation by reference of regulations governing domestic mail services.
- 111.2 Availability of the Domestic Mail Manual.
- 111.3 Amendments to the Domestic Mail Manual.
- 111.4 Approval of the Director of the Federal Register.
- 111.5 Contents of the Domestic Mail Manual.

AUTHORITY: 5 U.S.C. 552(a); 39 U.S.C. 101, 401, 403, 404, 3001-3011, 3201-3219, 3402-3406, 3621, 3626, 5001.

SOURCE: 44 FR 39852, July 6, 1979, unless otherwise noted.

§111.1 Domestic Mail Manual; incorporated by reference of regulations governing domestic mail services.

Section 552(a) of title 5, U.S.C., relating to the public information requirements of the Administrative Procedure Act, provides in pertinent part that " * * matter reasonably available to the class of persons affected thereby is deemed published in the FEDERAL REGISTER when incorporated by reference therein with the approval of the Director of the Federal Register." In conformity with that provision, and with 39 U.S.C. section 410(b)(1), and as provided in this part, the U.S. Postal Service hereby incorporates by reference in this part, the Domestic Mail Manual, a looseleaf document published twice each year in January and July, unless otherwise determined by the Postal Service.

[62 FR 14827, Mar. 28, 1997]

§111.2 Availability of the Domestic Mail Manual.

(a) Copies of the Domestic Mail Manual, both current and previous issues, are available during regular business hours for reference and public inspection at the U.S. Postal Service Library, National Headquarters in Washington,

DC. Copies of only the current issue are available during regular business hours for public inspection at area and district offices of the Postal Service and at all post offices, classified stations, and classified branches.

(b) A copy of the current Domestic Mail Manual is on file with the Director, Office of the Federal Register, National Archives and Records Administration, 800 North Capitol Street, NW, Suite 700, Washington, DC.

(c) A 1-year subscription to the Domestic Mail Manual for two consecutive issues can be purchased by the public from the Superintendent of Documents, Washington, DC 20540-9375.

[62 FR 14827, Mar. 28, 1997]

§111.3 Amendments to the Domestic Mail Manual.

(a) Except for interim or final regulations published as provided in paragraph (b) of this section, only notices rather than complete text of changes made to the Domestic Mail Manual are published in the FEDERAL REGISTER. These notices are published in the form of one summary transmittal letter for each issue of the Domestic Mail Manual. A complete issue of the Domestic Mail Manual, including the text of all changes published to date, will be filed with the Director, Office of the Federal Register. Subscribers to the Domestic Mail Manual receive the latest issue of the Domestic Mail Manual from the Government Printing Office.

(b) When the Postal Service invites comments from the public on a proposed change to the Domestic Mail Manual, the proposed change and, if adopted, the full text of the interim or the final regulation is published in the FEDERAL REGISTER.

(c) The Postal Bulletin contains the full text of all interim and final regulations published as provided in paragraph (b) of this section, and the full text of all other changes to the Domestic Mail Manual that are summarized in the notices published under paragraph (a) of this section, except for nonsubstantive changes and corrections of typographical errors. The

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